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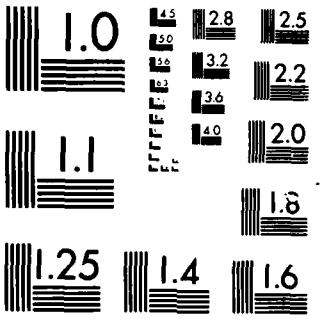

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U.S. ARMY MICOM SCIENTIFIC and ENGINEERING SUPPORT

COMPUTATIONAL CAPABILITIES REQUIREMENTS ANALYSIS

STUDY REPORT

EXECUTIVE SUMMARY

NOVEMBER 15, 1985

Prepared For: Commander
US Army Missile Command
ATTN: AMSMI-WPA
Redstone Arsenal, AL 35898-5170

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The basic questions addressed were what is the total near and long-term scientific and engineering computing requirements and what is the best way to effectively meet the requirements. The study identified and analyzed the requirements, developed alternatives for satisfying the requirements, and recommended cost effective approaches to satisfying the near and long-term requirements. The findings and recommendations were presented in an Executive Summary, Management Overview, and a Requirements Analysis Technical Report.

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U.S. ARMY MICOM SCIENTIFIC AND ENGINEERING SUPPORT COMPUTATIONAL CAPABILITIES REQUIREMENTS ANALYSIS

EXECUTIVE SUMMARY

1. **PURPOSE:** The purpose of the study was to analyze and determine the total Scientific and Engineering computing requirements of MICOM over the near-term (5 years) and long-term (10 years); and to determine the best way to satisfy the computing requirements over the near and long-term.

2. **BACKGROUND:** Inter Systems, Inc. (ISI) was selected to determine the S&E Computing Requirements; to analyze technical approaches and alternatives; and to develop a Master Plan and Implementation Strategy aimed at meeting the requirements in a cost-effective and forward-looking manner. The study began in February 1985. The data collection process was terminated during August 1985. The data was reduced and analyzed, and three documents were produced: an Executive Summary, a Management Overview and a Requirements Analysis Technical Report. These documents were delivered in final form, during November 1985. The Management Overview document is close to 100 pages in length; and, the Requirements Analysis Technical Report is over 200 pages long.

3. **STUDY METHODOLOGY:** Information and data were gathered from 25 designated MICOM organizations, which included 13 Project Management Offices, 4 Staff Offices and 8 Functional Directorates. A three-dimensional analytical data collection approach was used to collect data from an Organizational Perspective, from a Computer-Applications perspective and from the S&E User's Perspective. A survey questionnaire was created for each perspective (ORGANIZATIONAL, APPLICATION, and USER). The questionnaires were distributed and explained, during preliminary interviews. The questionnaires were completed, during formal follow-up interviews. Interviews were conducted with over 300 individuals, which included a cross-section of managerial and technical personnel. The Organizational Level Questionnaire requested information on points of contact; size, and complexity of the S&E User Community; organizational problems and sentiment; computer applications; and, current and future hardware, software and telecommunications requirements. The Application Level Questionnaire requested technical information on computer applications and the User groups for each application. The User Level Questionnaire requested more information on computer applications; hardware and software needs; the variety of work that is performed in the User's organizational element; and, problem areas and concerns of the Users as they relate to S&E Computing Requirements. Data was collected on 107 Organizational Level Questionnaires, 70 Application Level Questionnaires and 148 User Level Questionnaires. Historic computing workload information was developed for the S&E Central Computing Facility. The data collected was edited and organized into various databases. These databases were used to develop tables and plots used in the final reports. The data collected provided a brief investigation of the past, permitted an analysis of the current S&E Computing Environment, and provided a look into the future. From this analysis, a definition of the overall problem was formulated. Then, the

requirements were analyzed and quantified. The system implementation alternatives were developed and evaluated. As a result of this analysis, specific current, near, and long-term recommendations were made. A Master Plan and Implementation Strategy and supporting life cycle implementation cost estimates were developed, around the recommendations that were made.

4. **LIMITS OF THE ANALYSIS:** The conduct of this study effort was hampered by the level of cooperation provided by the various MICOM organizations surveyed. Throughout the data collection effort there was a definite lack of the perception that this was an important, high-priority effort. There was an extremely high level of resistance to the data collection effort, due to local politics. Accurate representations of equipment inventory, projected ADPE acquisitions and associated costs, current and future applications and automation requirements, actual numbers of current and anticipated Computer Users, and specific requirements, were difficult to extract from many organizations. But, as the study progressed, more of the working-level Users were interviewed and a better indication of the overall problems and requirements surfaced.

5. **SUMMARY OF THE FINDINGS:** IMD currently does not have adequate hardware, software and telecommunications capabilities to properly perform its MISSION responsibilities to provide and maintain "state-of-the-art" data processing technology for the Scientific and Engineering Community at MICOM. The immediate computing needs of the S&E Community are currently not being adequately met by the existing cadre of obsolete computer hardware, software capabilities, and telecommunications capabilities that exist on Redstone Arsenal. Immediate Top Management actions are required to improve the S&E Computing Environment at MICOM, both at the Central Computing Facility and down through the User's work areas. Significant long-term strategic planning and implementation activities must take place to ensure that a productive work environment exists for the scientists and engineers over the next decade.

The number of S&E Computer Users has grown from less than 100 in 1971, to between 1,622 and 2,497 in 1985. The number of S&E Users is expected to reach a peak of 4,000, during the next ten years. In 1971, the CDC 6600 mainframe was installed; and, within a year, approximately one hundred individuals were utilizing the S&E Computing Center. During 1971-1980, the number of individuals, using the Central Computing Facility, grew to over 600 people. In 1978, a CYBER 74 mainframe was added to the center. During 1978 to 1980, between 500 and 600 Users were generating a computing workload, which saturated both mainframes. Between 1975 and 1979, 102 computers were installed at MICOM; and, another 133 computers were added between 1980 and 1984. The majority of these computers are powerful minicomputers and microcomputers in the .1 to 4 Million Instruction Per Second (MIPS) processor range. The survey identified 441 more computers on the Arsenal. Collectively, the estimated number of 722 computers represent approximately 345.9 MIPS of computing power, or an average of .479 MIPS per computer. Still the Command does not have enough computing power; additional computer time is obtained from about 100 different contractors, universities and other government agencies. Some supercomputer time is purchased from various sources. Mainframe computer time is purchased from organizations, who have computers with processor speeds in excess of 15 MIPS. It is evident that MICOM spends millions of dollars, each year, on outside computer timesharing services.

Many MICOM organizations believe that the only solution is to obtain more minis and micros. Data collected during the survey indicated that MICOM organizations plan to acquire large numbers of minicomputers and microcomputers, over the next ten years. Figure 1 shows the estimated ten year ADPE life cycle costs according to data collected. The low-end quantities reflect data collected from the organizations and the high-end quantities reflect the potential impacts of the DA Microcomputer and Minicomputer Buys. ISI estimates that MICOM will spend between 205.22 and 408.36 million dollars on ADPE for what amounts to a be large number of minicomputers and microcomputers. More cost-effective alternatives should be examined.

Substantial problem areas surfaced during the course of this study. The spectrum of problems encompass technical, organizational, political, economic, management, procurement, training, support and User problems. There is a lack of adequate computer hardware, software and telecommunications capabilities to support the growing demands of the S&E Community. The organizations face a critical shortage of properly trained people, who can effectively deal with state-of-the-art computing problems and issues. The issue of "CONTROL" is always present. There is either a lack of funds or too much ADP approval effort required to acquire the types of equipment that are really needed. Management's perceptions of the User's needs conflicts with the User's wants and desires. Management feels helpless against the "system".

The procurement process takes too long, requires too much paperwork, and does not adequately support the AIF operated organizations. Training has been a problem in the Past and will become an even greater problem in the Future. The Command needs a more expanded level of ADP support than has been provided in the Past. User problems that are direct result of the poor S&E Computing Environment that exists at MICOM include: poor morale among members of the S&E Community, diminished and impeded productivity, negative attitudes, frustration, and the feeling that nobody cares about their problems and nobody is going to do anything about their problems. The Users cannot effectively support their organization's MISSION without the proper ADP tools. These problem areas are more thoroughly addressed in the management and technical reports.

There are substantial non-tactical S&E and S&E related ADP and telecommunications requirements at MICOM. These requirements continue to grow in complexity, as the weapon systems become increasingly more complex. As the S&E Community becomes more dependent upon analytical techniques that address analysis of the problem at hand from a total systems approach and analytical techniques migrate from two into three-dimensional analyses; the demands for larger memory, faster central processor speeds and proportionally higher data transmission rates will become commonplace. Powerful mini and microcomputers currently cannot satisfy these demands. Large-scale mainframes and supercomputers must be used to address the computing requirements. A network of mainframe computers supporting access to a supercomputer will satisfy many of the S&E Computing Requirements.

MICOM HARDWARE AND SOFTWARE LIFE CYCLE COST ESTIMATES

ADPE EQUIPMENT CATEGORY	QUANTITY	LIFE CYCLE ACQUISITION COSTS	LIFE CYCLE MAINTENANCE COSTS	LIFE CYCLE SOFTWARE ACQUISITION AND MAINTENANCE COSTS	LIFE CYCLE HARDWARE AND SOFTWARE COSTS
MAINFRAMES	1 - 2	$ 3,200,000 - 6,200,000	$ 1,300,000 - 2,800,000	$ 2,000,000 - 4,000,000	$ 6,500,000 - 13,000,000
MINI	72 - 144	43,200,000 - 86,400,000	17,280,000 - 34,560,000	72,000,000 - 144,000,000	132,480,000 - 264,960,000
SUPER MICRO	450 - 600	27,000,000 - 36,000,000	10,800,000 - 14,400,000	13,500,000 - 18,000,000	51,300,000 - 68,400,000
PERSONAL MICRO	482 - 2000	7,230,000 - 30,000,000	2,892,000 - 12,000,000	4,820,000 - 20,000,000	14,942,000 - 62,000,000
		$ 80,630,000 - 158,600,000	$ 32,272,000 - 63,760,000	$ 92,320,000 - 186,000,000	$ 205,222,000 - 408,360,000

Figure 1 MICOM ADP Hardware and Software Life Cycle Cost Estimates

The Computers made available to the S&E Users are considered quite useless, unless a rich variety of "easy to use" software tools are readily available to the Users. The Users want to spend less time "programming" the computers, and more time analyzing the results that can be generated by the computers. A large number of software capabilities are required in the following categories: DATABASE MANAGEMENT SYSTEMS, ENGINEERING PACKAGES, GRAPHICS PACKAGES, PROGRAMMING LANGUAGES, PROJECT MANAGEMENT PACKAGES, SCIENTIFIC SOFTWARE LIBRARIES AND CODES, STATISTICAL PACKAGES, SIMULATION/MODELING PACKAGES, P.C. COMMUNICATIONS PACKAGES, WORD PROCESSING PACKAGES, and CAD/CAM and FACTORY AUTOMATION. These software capabilities are required at all levels of hardware: micro, mini, mainframe and supercomputer.

The growing number of Computer Users and the tremendous growth in the number of computers and peripheral devices required to support the Users, will generate a substantial telecommunications requirement, over the next decade. Extensive networking of all levels of computers is required. High-speed (50 Mbits per second) network connections are needed to provide mainframe-to-mainframe and mainframe-to-minicomputer communications. Lower-speed (10 Mbits per second) networking connections are needed to provide communications between personal computers and minicomputers. Various local area networks within various organizations will need to communicate with distant local area networks. A high-speed fiber-optics backbone network will be needed to allow all of MICOM's networks to be tied together. Serious long-term telecommunications planning needs to be done NOW. Telecommunications will become the single most important element of a successful S&E Computing Environment.

IMD has not aggressively pursued the concept of providing TOTAL SUPPORT for the Scientific and Engineering Community's Computing Requirements. IMD needs to expand and improve the areas of service it provides in terms of hardware, software, telecommunications, consulting, training and End-User services. IMD needs to become a provider of TURNKEY SOLUTIONS to the S&E User's ADP Requirements. IMD needs to design, implement, operate, maintain and support a state-of-the-art Scientific and Engineering Computing System, which will be capable of addressing the TOTAL S&E Computing Requirements, in a cost-effective and forward-looking manner. IMD needs the total support and total cooperation from all MICOM organizations to accomplish this MISSION.

MICOM has a very serious computer literacy problem that can only be rectified by a comprehensive training program directed at all levels of management, all levels of technical staff, and, all levels of support staff. Millions of dollars are being spent to "put a microcomputer on every desk," but people are not being properly trained to effectively use the hardware and software tools, that are provided for their use. People are being sent off to school to learn about hardware and software, before they even have a basic understanding of what data processing is all about. They return from the classes more confused about the hardware and software, than they were before they attended the classes. Fundamental data processing training must be provided before students are sent off to learn about specific hardware and software capabilities. Furthermore, the inadequately trained Users can spend months trying to solve simple technical applications development problems,

because they have nowhere to go for application development assistance, trouble-shooting, and general support. MICOM needs a customized training program to address the ADP training needs of the Command; and, needs to develop a comprehensive End-User Application Hotline Support Service.

6. **ALTERNATIVES:** Basically four alternative approaches were examined as potential solutions to the S&E Computing Problem that exists at MICOM. The first alternative is to do nothing. Everything remains status quo. This alternative was dismissed as being a non-viable alternative, because of its adverse effects on the Command. It would result in the economic demise of the S&E Computing Facility and further propagate the proliferation of computers on the Arsenal. The User's requirements would not be met, and, this avenue is not a cost-effective alternative.

A viable approach is to design and implement a Scientific and Engineering Computing System, which will address the TOTAL S&E Computing Requirements, over the next ten-years. Three conceptual system implementation approaches were evaluated: Total Centralization, Total Decentralization, and a Distributed Hierarchical Data Processing System approach. The relative advantages and disadvantages of each approach were identified and evaluated. Total Centralization ranks as the most cost-effective alternative. Total Decentralization ranks as the least cost-effective alternative. The Distributed Hierarchical Data Processing System approach ranks as a mid-road cost-effective approach, that recognizes the need for a controlled mix of supercomputers, mainframes, minicomputers and microcomputers to support the S&E User Community. A carefully planned network of computers is a feasible way of handling the TOTAL MICOM S&E Computing Requirements in a cost-effective and forward-looking manner. An Integrated Data Communications Utility Network would serve as the heart of the system, providing high-speed data transmission services between local computers and local area networks. It would also provide gateways to the Army Supercomputer Network and other networks, as required.

Currently MICOM is rapidly marching down the path of Total Decentralization; and, over the next decade, will spend between 205.22 and 408.36 million dollars, on predominantly minicomputers and microcomputers (See Figure 1). This is enough money to acquire and operate between 15 and 31 dual-processor mainframe configurations. Viewing it from a different perspective, MICOM could acquire between 8 and 17 advanced CRAY supercomputers for the same dollar expenditures. Clearly, MICOM TOP MANAGEMENT must decide to pursue a more cost-effective approach that will still satisfy the computing needs of the Command, but for significantly less dollar expenditures.

7. **RECOMMENDATIONS:** IMD must design, implement, operate, maintain, and support, a Distributed Hierarchical Data Processing System to meet the growing long-term computing needs of the Scientific and Engineering Community at MICOM. A controlled mix of supercomputers, mainframes, minicomputers and microcomputers is needed to address the TOTAL S&E REQUIREMENTS, that will be generated by somewhere between 3,500 and 4,000 S&E Users, over the long-term. An Integrated Data Communications Utility Network must be designed and implemented to interconnect all levels of computers and various levels of networks on the Arsenal. The Network and Distributed Hierarchical Data Processing System must be procured, installed, operated, maintained and supported on a TURNKEY BASIS. The objective of the system must be to

economically satisfy the TOTAL S&E Computing Requirements, over the long-term. IMD should engage the services of a Turnkey Telecommunications Networking, Systems Design and Systems Integration contractor to further study, design, develop and implement the system. Additional activities, necessary to accomplish Phase II of the Master Plan and Implementation Strategy, are discussed in Section 1.9 of the Management Overview document.

As an interim solution to the current S&E Computing Problems (i.e., lack of sufficient central memory and adequate central processor speed), the existing mainframes and selected peripherals must be replaced IMMEDIATELY. A contract vehicle needs to be developed to accomplish this activity as soon as possible. The contract vehicle must include equipment acquisition, installation, maintenance and analyst support services. An additional contract vehicle is required to procure End-User equipment acquisition, installation, training, maintenance, User support and consulting services. A third contract vehicle is required to procure turnkey software support services to include: software studies, software acquisition, installation, testing, analysis, demonstration to the User Community, training, User support and consultation services in determining which software packages a User should use for their particular application and on which level and type of hardware their application should be executed on. This vehicle can be used to deliver software packages to the End-Users, as a service of IMD. Additional recommended activities are presented in the discussion of Phase I of the Master Plan and Implementation Strategy which is contained in the Management Overview document.

IMD and the Career Development Center Management need to work together, and establish a local Demonstration and Training Facility. Equipment should be acquired to facilitate training activities. A contractor should be acquired to provide local turnkey training services. Customized training programs should be developed for the User Community.

IMD needs to expand and improve the areas of service that it currently provides; and decisions, about the future scope of services, need to be made. IMD needs to develop a foundation upon which to build a TOTAL TURNKEY SUPPORT capability. These activities will help to bring about a standard method of operation and support for the S&E Community.

IMD needs to prepare to get into the Supercomputer support business. Long-range plans must be made to augment the S&E Computing Environment at MICOM, with a Hardware Vector Processing Capability. The recommended steps to accomplish Phase III of the Master Plan and Implementation Strategy are discussed in Section 1.9 of the Management Overview document.

IMD needs to become actively involved in New Technology Assessment duties. IMD must actively pursue and seek out new technologies, evaluate their usefulness to the S&E Community at MICOM, and introduce new technology into the S&E Computing Environment at MICOM, when it is appropriate. The recommended steps to accomplish Phase IV of the Master Plan and Implementation Strategy are discussed in the Management Overview document.

IMD should consider becoming a provider of turnkey support for distributed systems. This business concept involves providing mainframes, minicomputers and microcomputers along with some support, for unique application areas that might not be totally supported by IMD due to their unique characteristics. Turnkey hardware and software solutions would be provided to the End-Users, as a service. Interfacing/connection services to the MICOM S&E Network would be standard operating procedure. This constitutes Phase V of the Master Plan.

IMD should become the focal point for the ADP needs of the Command. IMD needs to finalize and adopt a long-range data processing and telecommunications plan geared towards meeting the TOTAL S&E Computing Requirements, over the next ten years. The multi-phased plan outlined in the Management Overview document can be used to meet MICOM S&E Computing Requirements in a cost-effective and forward-looking manner, if it is adopted.

A complete S&E Computing System, which would satisfy the computing needs of the S&E Community well into the late 1990s, could be designed, implemented, operated and maintained for 100-200 million dollars less than MICOM will spend if current trends are permitted to continue.

The acceptance of the Distributed Hierarchical Data Processing System concept would solve three major problems that exist in the current scheme of ADPE at MICOM: the multiplicative life cycle costs for mini and micro hardware configuration maintenance; redundant life cycle cost for software packages and their maintenance; and, redundant cost of operating too many computer centers. These problems would be resolved by minimizing the number of minis and micros; and, increasing the utilization of mainframes. The number of computing centers would be minimized. The Central Computing Facility would consist of at least two mainframe front-end configurations supporting access to a supercomputer. Some number of distributed computer centers would be created. Possibly five to twelve such centers would be needed. The six to thirteen data centers would be connected by a high-speed backbone network. Network gateways would support the variety of local area networks that organizations plan to create. A detailed system design effort would determine the actual requirements for data center distribution and networking requirements. The number of data centers and their location would be determined by technical network topology and "total system" performance requirements.

This concept facilitates TOTAL S&E Workload Management at a significant cost savings and it will provide more than adequate computing capabilities to the S&E Community. The technical approach to the solution of the problem has been presented. The final recommendation is that MICOM should create a Distributed Hierarchical Data Processing System, supported by an Integrated Data Communications Utility Network, in order to meet the growing needs of the S&E Community. The suggested Master Plan and Implementation Strategy should be adopted and related study and design efforts should begin as soon as possible. In the interim, the existing mainframes should be replaced IMMEDIATELY. The replacement machine will serve as one of the mainframe front-ends recommended in the general design presented above.

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